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SCIENCE AND TECHNOLOGY FOR SUSTAINABLE DEVELOPMENT: TRANSFER AND APPLICATION OF ENVIRONMENTALLY SOUND ENERGY TECHNOLOGIES

Utilization and marketing of energy technologies, focusing on policy issues and options for the effective transfer and application of environmentally sound energy technologies

Report of the Secretary-General

SUMMARY

Technologies exist or are emerging on the market that hold considerable potential for the efficient and cleaner generation and use of energy. Policies are needed to provide options at both national and international levels for creating a favourable environment for the effective transfer and application of environmentally sound energy technologies in developing countries. Such policies should include the necessary institutional arrangements for the dissemination of information on available and emerging energy technologies and should identify sources of financing and other forms of assistance for technology transfer.

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CONTENTS

	Paragraphs	Page
INTRODUCTION	1 - 5	3
I. THE TECHNOLOGY	6 - 24	3
A. Fossil fuel technologies	6 - 18	3
B. Energy-related technologies for the building sector	19 - 20	6
C. New and renewable energy technologies	21 - 24	6
II. POLICY ISSUES AND OPTIONS FOR THE EFFECTIVE TRANSFER AND APPLICATION OF ENVIRONMENTALLY SOUND ENERGY TECHNOLOGIES	25 - 94	7
A. Domestic market policies	27 - 54	7
B. Capacity-building	55 - 63	11
C. Technology-transfer policies	64 - 94	13
III. CONCLUSIONS	95 - 99	18

INTRODUCTION

1. This report was prepared in pursuance of resolution 1 (XI), adopted by the former Intergovernmental Committee on Science and Technology for Development at its eleventh session. 1/

2. In preparing this study, extensive use was made of publications, particularly those submitted by the Department of Economic and Social Development, 2/ the United Nations Conference on Trade and Development, the United Nations Development Programme, the United Nations Environment Programme, the regional commissions, the United Nations Centre for Human Settlements, the World Bank, the World Intellectual Property Organization, and the United Nations Industrial Development Organization. In addition, the report draws on publications and interviews with a number of organizations external to the United Nations system, including the International Institute for Energy Conservation, which has initiated several programmes for the commercialization and transfer of environmentally sound energy technologies for developing countries.

3. Various examples taken from the institutional and legislative experiences of a number of countries are provided. In addition, major activities of the United Nations system in areas related to the theme are included.

4. Section I provides a brief description of the range of available and emerging energy technologies. Section II discusses policy issues and options for the effective transfer and application of environmentally sound energy technologies, particularly with regard to appropriate domestic and transfer policies, capacity-building, financing and other forms of assistance. In section III a number of conclusions are proposed.

5. The activities suggested in the report would ensure the active participation of the Commission on Science and Technology in translating Agenda 21 recommendations (see A/CONF.151/26/Rev.1 (vol. I)) into concrete policies and measures.

I. THE TECHNOLOGY

A. Fossil fuel technologies

6. Coal provides the basis for meeting about 30 per cent of world energy demand and 47 per cent of electricity demand. At the same time, coal mining and combustion are sources of heavy pollution, underscoring the need to identify, commercialize and transfer clean-coal technologies. Technologies exist or are emerging on the market which appear to hold considerable potential for the efficient and cleaner generation of electricity based on coal resources. In this connection, a series of conferences organized by the Department of Economic and Social Development were held recently in China, India and Germany to examine both the technological and policy options available to promote clean-coal technologies for developing countries. 3/

7. Mine production incentives based on energy production instead of tonnage minimize the use of coal with high ash content. Nevertheless, high ash and sulphur levels sometimes exist in the raw coal. Therefore, various forms of coal upgrading should be considered to improve coal quality, including simple screening to meet the size specifications for effective combustion in fixed-grate (stoker-type) industrial boilers; traditional coal washing to reduce ash and sulphur; and advanced coal washing to produce coals of ultra-low ash and sulphur levels. Fluidized-bed combustion boilers, briquettes and pyritic-based sulphuric acid production and use in brickmaking can also help alleviate environmental problems resulting from coal-washing waste, while methane recovered from coal seams before mining can be used as a fuel for district heating and electricity generation.

8. The Clean Coal Demonstration Program of the United States Department of Energy is testing 39 full-scale demonstration projects of such technologies as circulating fluidized-bed combustors; pressurized fluidized-bed combustors; integrated gasification combined cycle systems; advanced slagging combustors; and a number of process technologies, such as gas suspension absorption, confined zone dispersion and limestone scrubbers. The first two phases of this multi-year programme have included 11 projects, with contributions of $279 million from the Government and $527 million from United States industries. 4/ Many of the newer clean-coal technologies are still in the demonstration phase and have yet to be commercialized.

9. Coal use in the industrial and utility sectors can be integrated with energy requirements in the domestic sector. For example, both gasified coal and methane-rich coke oven gas can be effectively used as town gas to replace direct coal combustion for residential heating and cooking. Similarly, process steam from electric utility and large industrial boilers can be used for district heating in the residential, commercial and institutional (for example, schools, hospitals) sectors.

10. Existing electric utility coal-fired boilers in many developing countries are relatively inefficient and have minimal environmental controls. High stacks, which disperse the pollution, merely exchange a local pollution problem for a regional or global one. Although modern coal-fired power plants are inefficient relative to cogeneration, leap-frogging to next-generation technologies may prove to be impractical due to front-end capital cost, risk and lack of appropriate skills. Any assessment of power-generating technologies based on efficiency, environment and cost must also take into consideration both the scope for upgrading conventional technologies through plant rehabilitation and fuel switching and load/demand management.

11. The consultative meetings of the Stockholm Initiative on Energy, Environment and Sustainable Development have stressed the importance of plant rehabilitation over capacity expansion, with an emphasis on recurrent funding for preventive maintenance and spare parts programmes; the selection and rewarding of qualified and motivated personnel; international guidelines for training and human resource development; and closer cooperation between utilities in developed and developing countries in order to transfer experience, analytical and operational systems and organizational structures. 5/

Management technologies

12. The application of least-cost planning approaches and demand management makes it possible to serve more consumers, either with the same amount of energy or without additional investment in power plants, through, for example, demand-reducing schemes, including information and consumer-level efficiency studies; enhancement of the efficiency, use and environmental characteristics of existing capacity; preferential purchase of electricity from private suppliers; and implementation of caps on emissions.

13. Proper organization and management of the workfloor, as well as regular equipment maintenance, can improve energy efficiency. The design of buildings with respect to lighting, space and air-conditioning is also important.

14. In developing countries, transportation accounts for the largest share of petroleum consumption, which shows a stronger growth than other energy forms. In 1987, transportation accounted for about 44 per cent of the total demand for petroleum products in the 12 largest oil-consuming developing countries. That share has increased in recent years as oil use in other sectors, such as electricity generation and industry, has been displaced by coal and other fuels. Of this amount, 60 to 80 per cent is consumed by vehicles. Moreover, motor vehicles in countries that are members of the Organisation for Economic Cooperation and Development are the dominant source of carbon monoxide, nitrogen oxide and unburned hydrocarbons. Improving the efficiency of transportation technology may achieve a 10-20 per cent savings of oil over the next two decades, but increasing attention must also be given to moving away from an oil-based transportation system. 6/

15. Both compressed natural gas and ethanol are used in some countries as fuels. Compressed natural gas appears to be an attractive option for countries with large natural gas reserves, but it requires costly front-end investments in pipelines and compression facilities as well as vehicle conversions. Ethanol is another major option but its market success is dependent on a high cost of oil; ethanol/gasoline blends reduce oil imports but are not competitive at current oil prices. With all alternative fuels, three issues must be addressed before introduction of the technology:

(a) A research and development programme must be in place to link development of vehicles or any other related technologies with the requirements of the fuel and to ensure that appropriate standards are enacted to protect the public;

(b) The utilities should take the leadership role for (and thus a major stake in) the innovation;

(c) Long-term planning must be recognized to be as critical as the short-term planning which has generally characterized the use of alternative fuels. 7/

16. The catalytic converter was introduced in 1975. Initially composed of oxidation catalysts, the three-way converter of the 1980s is capable of lowering carbon monoxide, hydrocarbon and nitrogen oxide emissions simultaneously but has little effect on carbon dioxide emissions.

17. Modal mixes of informal and formal transport, and of fuel-powered and people-powered transport, also deserve attention. For example, private, informal means of mass transit, such as jitneys and jeepneys, may serve as connectors between semi-rural areas and the main train/subway/bus lines into the cities. Two and three-wheeled bicycles can be used to transport people and light goods, particularly if encouraged through special bicycle lanes or designated side-roads.

18. One of the most important ways to increase energy efficiency is not through new technologies but through programmes promoting proper maintenance of existing vehicles on the road. This implies access to or fabrication of spare parts, technical knowledge and organization for inspections and servicing.

B. Energy-related technologies for the building sector

19. Lighting and heating requirements for commercial buildings constitute one of the fastest growing energy demand sectors, with implications for both commercial and household design and construction. Opportunities to increase efficiency include better heating, cooling and lighting equipment; appropriate use of energy controls; better insulation; more efficient building shells (for example, better windows); and use of reflective roof coatings, shading and natural light.

20. In the United States of America, for example, 28 per cent of total energy in commercial buildings and 7 per cent in households is used just for lighting; water heating accounts for 15 per cent of household and 4 per cent of commercial energy use; and food refrigeration and freezing use about 10 per cent of household energy and 5 per cent of commercial energy. Vastly improved technologies are available in all three areas, and a considerable potential for further improvement remains. 8/

C. New and renewable energy technologies

21. The majority of households in developing countries, however, are not connected to an electric grid. Energy is needed but most commercialized forms are not available. There are an increasing number of promising technologies which lend themselves to the "disconnected", including technologies for the combustion of biomass (particularly of agricultural residues), the anaerobic production of biogas and the production of alternative fuels.

22. Considerable attention is also being given to improved solar, wind and water-powered technologies. Innovations in solar energy technologies are available for heating, drying, water treatment, refrigeration and cooling, cooking, water pumping and thermal and photovoltaic electric power generation. Photovoltaic energy, in particular, has witnessed significant growth in application, as a result of advances in materials science and related fields. Large-scale photovoltaic applications, including those for grid connections, have also increased substantially in recent years. 9/ At present, the world's largest rural electrification programme using photovoltaics is being implemented in Mexico as a part of that country's rural electrification strategy. 10/

23. Unfortunately, most solar-based applications lack world-wide commercialization due to a combination of high initial investment and small markets; heavily subsidized energy prices in many countries; the poor quality and design of many of the technologies; the shortage of techno-economic studies, information dissemination and promotion; and the lack of a meaningful market research and commercialization strategy. 11/

24. Mini and micro-hydro plants are already in operation throughout the developing world, while new designs for wind turbines, capable of harnessing wind energy for household and agricultural electricity, water pumping and even distribution through the grid, are on the market and under development. The use of hydrogen for heat generation, fuel and direct electricity production using fuel cells is also being researched and developed.

II. POLICY ISSUES AND OPTIONS FOR THE EFFECTIVE TRANSFER AND APPLICATION OF ENVIRONMENTALLY SOUND ENERGY TECHNOLOGIES

25. Domestic market policies, capacity-building requirements and technology transfer policies are interrelated elements to be considered in the formulation of strategies and programmes for the effective transfer and application of environmentally sound energy technologies in developing countries.

26. Several policy instruments that have been used successfully in some countries are illustrated. However, it is not possible to determine which of these policies, singly or in combination, should be implemented, since the effect of any policy is widely influenced by other economic, political and social variables. Prescriptions require a case-by-case approach.

A. Domestic market policies

Consumer awareness

27. A number of policies designed to influence the behaviour of consumers by keeping them informed have been adopted by developing countries, including the use of energy efficiency stickers on appropriate consumer items (for example, automobiles and electric appliances) and disseminating information through both print and electronic media. These programmes are important and should be encouraged, but recent studies have indicated that they are not likely to be permanently effective if used alone.

28. For example, PROCEL, the conservation programme of Electrobras in Brazil, has undertaken studies of demand; held seminars, training and media campaigns on energy conservation technologies; funded the relamping of street lights with high-pressure sodium bulbs; conducted research on appliance efficiency; and sponsored demonstration projects in industrial cogeneration and conservation in commercial and public buildings. 12/

29. One study in the United States concluded that in many cases, it has proven to be far easier and more effective to remove or discourage inefficient products from the market, rather than to try to educate consumers on how to make

individual energy purchase decisions. Indeed, energy standards result in more savings than other methods, including tax credits, rebates and consumer education. 13/

30. Similar conclusions were drawn in Brazil, where it was found that there is little to be done with respect to the way the customers operate their appliances. Most of the work in energy conservation, the authors of one study stated, should be directed to improving the efficiency of the equipment itself and ensuring good marketing and financial backing in order to have efficient equipment reach the homes of the majority of the population. 14/

31. A third study on energy savings in Denmark between 1972 and 1988 found that most of the changes in energy efficiency were caused by permanent changes in technology, not temporary changes in behaviour. The relationship between behaviour and utilization is volatile and subject to rapid swings, caused by changes in prices or incomes or by other factors. 15/

32. The Energy Conservation and Efficiency Project in Egypt has as its primary objective the completion of 60 industrial conservation technology demonstrations in eight years. At the same time, it has supported programmes in energy conservation training and in the implementation of conservation technologies. 16/

33. Consumers, businesses and industry must all be made aware of the need to use and produce energy-efficient technologies. This may be achieved through awareness programmes, such as the above-mentioned programmes, through regulations and other government programmes, discussed in the present section of this report and through information dissemination, discussed in the last section of this report. In addition, support for research and development to ensure the availability of appropriate technologies must exist parallel to other programmes.

Taxes and regulations

34. Among European countries, Denmark, Finland, the Netherlands, Norway and Sweden have implemented carbon taxes (with some exceptions for carbon-intensive industries). Other countries have implicit carbon taxes. The European Community as a whole has agreed to a regional target and the Commission of the European Communities has proposed a community-wide energy-carbon (50:50) tax to reach $10/bbl ($42/ton carbon for the carbon component of the tax) by 2000. 17/

35. Carbon and other energy-related taxes can be used as efficiency-inducing measures in reducing energy intensity (the ratio of energy consumption to gross domestic product). A secondary target may be the raising of funds for new capital investment.

36. An alternative approach is based on tradeable permits, which place a cap on specific air pollution emissions in a geographic region. Industries are initially assigned individual ceilings or caps; those that control emissions under this cap may sell their rights to the remaining portion to another industry that wants or needs to maintain a level of pollution that exceeds the cap. These permits differ from taxes in at least two important ways: they directly affect only industry (although presumably consumers are indirectly

taxed by higher production costs) and they target a national level of environmental tolerance, not an individual level.

37. Taxes and tradeable permits work by levying a financial penalty against the excessive polluter, by trying to alter behaviour and by providing an incentive to invest in new, more energy-efficient technologies. If the demand for new technologies increases, their development and commercialization is more likely to follow in response.

Subsidies

38. Taxes increase the cost of using energy. However, in many developing countries, the opposite situation prevails: energy, particularly electricity, is highly subsidized. This policy of subsidization is rational from a political, social and humanitarian point of view in the short run. None the less, subsidies generally entail not only immediate economic and environmental costs but also long-term social costs.

39. At the same time, policies are needed which will introduce new technologies as subsidies are removed.

Cash rebates and incentives

40. Some developed countries, including the United States of America, Canada and Sweden, have established a "golden carrot programme", to promote development of technologies that exceed established standards of energy efficiency. This is accomplished in two ways. The first is through the provision of cash rebates to a large but fixed number of first purchasers of products in order to help ensure a sufficiently large volume of sales and market penetration. While this, in effect, may constitute a subsidy, it is not meant to make energy cheap but to help a new technology penetrate the market.

41. The second component of a "golden carrot" comprises large cash incentives to producers to offset incremental manufacturing costs. Such funds are often raised through consortia of utility manufacturers and other stakeholders. 18/

42. Still another incentive is the "freebate" for whole buildings, appliances and automobiles. For example, operating in a manner which exceeded a targeted energy use, as in the case of tradeable permits, would require owners of buildings to pay a fee. This fee would then be rebated to owners of buildings or technologies which used energy below the target, with a small portion withheld to support the administrative costs of the system. 19/

New technologies and fuel substitution

43. The present report has argued that support for new technologies in combination with fuel substitution is the single most important policy for promoting the commercialization of energy-efficient technologies. This conclusion has been confirmed by a number of studies undertaken in widely divergent countries. The Organisation for Economic Cooperation and Development (OECD) has concluded that assumptions about costs and the effectiveness of carbon taxes depend to a large extent on the availability, introduction and rate of market penetration of efficient technologies and other clean-energy

equipment. 20/ The OECD study concluded that fuel diversification or substitutability is key to reducing cost, or the level of tax required; backstop or low/no carbon technologies are critical; and eliminating fossil fuel price subsidies world wide would significantly reduce CO_2 emissions with net social benefit. 21/

44. This means that both public and private stakeholders need to support the research, development and demonstration of new energy-efficient technologies, as well as measures to encourage their penetration into the market which will require both imagination and financing. Funding for these activities may come from bilateral or multilateral agencies, including regional development banks; from private capital markets, including commercial lenders such as banks and insurance companies, the largest providers of senior and often syndicated debt; from pools of invested capital, such as pension funds and private investment funds; and from commercial sponsors. 22/

45. Funds can also be generated within the country. This often requires the creation of consortia of public and private interests, including government officials, industrialists, bankers and other businessmen.

46. In Argentina, for example, the Associación Argentina para el Uso Racional de la Energía, a non-profit business association, not only provides technical energy information to industrial and agricultural energy users but also helps draft legislation to promote alternative energy sources and fuel substitution and reduce taxes on energy-efficient equipment. 23/

47. In 1986, the Government of Tunisia created the Agence de Maîtrise de l'Énergie with a broad mandate to pursue conservation and renewable energy resource opportunities in all sectors. Audits sponsored by the Agency are provided by private engineering firms, which are reimbursed for 50 per cent of the cost of the audit. Upon completion of the audit, each company enters into a five-year contract with the Agency that specifies how the company will implement the recommendations. In exchange, the Agency funds 50 per cent of the cost of any audit-recommended training programme and 50 per cent of the cost of any pre-feasibility studies needed prior to investment in advanced efficiency improvements. Companies are also eligible for low-interest loans and are given various tax incentives. Initially, the Government funded these assistance programmes in part from a tax on fuel oil and gasoline. Financial assistance now comes directly from the Government's general funds.

48. The Agency is also supporting the creation of domestic firms for the joint-venture manufacture of insulation, high-efficiency lamps, air-conditioners and boilers for small businesses. It holds monthly meetings with the relevant industries to inform them of high-efficiency technologies and of overseas companies with whom they might form joint ventures and it is building a database of high-efficiency technologies relevant to Tunisia. 24/

49. The Energy Conservation and Efficiency Project of Egypt, discussed in paragraph 32 above, is undertaking 60 industrial conservation technology demonstrations in eight years. Rather than concentrating on any single plant or only a few plants, it identifies in each plant four areas where efficiency improvements are needed, funds one of them and recommends that the company fund the other three. 25/

50. China has organized support for the China Energy Conservation Company of the State Energy Investment Corporation. Funds are given to companies for both employing proven technologies and for demonstrating new technologies. The Company normally provides one third of a project's cost through a direct grant. Some additional funds come from federal ministries or local and provincial governments, but the primary funding comes from individual companies. 26/

51. Finally, one of the most recent examples of State support for energy-efficient technology is provided by Thailand, whose legislature has just approved legislation establishing the Energy Conservation Promotion Fund. With projected first-year appropriations of 1.5 billion baht ($60 million), the Fund may become the largest fund investing in energy efficiency and renewable energy of any nation in the world. Individuals, businesses, non-governmental organizations, government agencies and State enterprises may apply for grants to finance projects. Grants may be used for education, promotion, demonstration, monitoring, research and development, and policy and planning. The Fund has derived its money from three sources: the now defunct Petroleum Price Stabilization Fund, a levy on petroleum and natural gas refinery products and funds received from the local private sector and external lenders. 27/

Information

52. There is a need for policies to organize information on energy-efficient technologies in such a way as to make it accessible and relevant to all potential users. This is a critical requirement, which all of the national bodies, both public and private, discussed in the present report, as well as many other such organizations, are trying to satisfy.

53. The series of conferences on clean-coal technologies sponsored by the Department of Economic and Social Development stressed the usefulness of regional centres as a forum in which suppliers and recipients of technologies could exchange valuable technical information. 28/

54. The International Energy Agency of OECD has pointed out that the lack of reliable information in most countries on the breakdown of energy demand, the availability, costs and potential of efficient technologies and their efficiencies relative to current stock begs the question: if Governments do not know where they are today, how will they be able to monitor and measure their progress in the application of this policy tool? 29/

B. Capacity-building

55. If countries are to be able to successfully choose, adapt, absorb and manage the new technologies they acquire externally or generate internally, it will be necessary to develop and strengthen the institutions that make this possible. These institutions are clearly influenced by policy and regulation, which must provide an enabling environment in which they can develop.

56. The development of enabling environments and individual institutions on the scale of a sector or subsector is called capacity-building. Capacity-building thus involves development of institutions, their managerial systems and their human resources, which in turn require favourable policy environments.

Capacity-building in the energy sector is important for the successful transfer of environmentally sound energy technologies.

57. There are several areas of capacity-building which are necessary to achieve virtually any objective, including the commercialization and transfer of environmentally sound energy technologies. Of particular importance, however, are policy analysis and planning; organization; human resource development, with particular emphasis on managerial training; information; and technology assessment.

58. It is especially important that organizations, even those established as entities of a central Government, work only when they have strong linkages with industry and research and development, and where training has been implicit throughout. Those involved must be conversant with energy audits and their implementation; they must be able to understand the connection between energy efficiency and development goals; they must be able to work with new technologies and to organize themselves on the shop floor to be energy-efficient. This demands strong management capabilities. The United Nations Educational, Scientific and Cultural Organization has consistently provided training courses in these areas. 30/

59. The need for well organized and accessible information on new energy technologies has been discussed in paragraphs 52-54 above and will be discussed in more detail in paragraphs 83-94 below.

60. Technology assessment conjures up images of large, well staffed organizations with sophisticated methodologies employing sophisticated equipment and sophisticated people. Only the last need be true. A technology assessment capability may be a single large or small organization; it may be the nucleus of a larger agency; or it may be a network or consortium of organizations involved in research, development, demonstration, information, policy, planning and industry. It may employ computer models for assessment, or it may rely on dialogue with relevant stakeholders. Most likely it will do both, but neither computers nor modelling are necessary.

61. All capabilities for good technology assessment have the following in common: a method to identify a technology-related issue or question; access to relevant information internationally; access to those affected by the technology, whether suppliers, industrial/commercial users, consumers or the financial community; a capacity to analyse and value a number of variables; and access to decision makers.

62. What variables does technology assessment measure and weigh? It looks at the comparative economic, social, environmental and political costs of a technology or group of technologies. In the absence of complete information and this kind of analysis, it will be difficult for any country to choose and commercialize environmentally sound energy technologies wisely.

63. National capacities for technology assessment may be strengthened and enriched through a number of international programmes, such as the Advanced Technology Assessment System (ATAS) of the United Nations Department of Economic and Social Development and appropriate non-governmental organizations. Other entities which could assist national efforts include the proposed International

Association of Technology Assessment Institutions, 31/ as well as, on a sectoral basis, the proposed Regional Clean-Coal Centres, the International Centre for Hydrogen Energy Technology and the International Centre for the Advancement of Solar Energy. 32/

C. Technology-transfer policies

64. Besides multilateral or bilateral technical assistance, developing countries can gain access to technology by a series of mechanisms, such as the importation of capital goods, foreign direct investment and by obtaining licenses. Foreign direct investment, in particular, with its many variations, offers new know-how in the production process, management and marketing. Joint ventures are also a way of combining foreign investment and technology transfer. Industry itself decides where to invest, but Governments in developing countries can influence the behaviour of companies to a certain extent by liberalizing the investment climate. Transparency and stability of regulations are important in this respect.

65. Foreign investment will of course occur in sectors in which developing countries have a comparative advantage. Research shows that the per capita volume of foreign investment is greater in countries with an outward-looking policy. Therefore, private capital markets are more available to a strong sponsor with a track record for completing projects on time and for working with suppliers and bankers; a practicable economic need, with long-lived, strong, stable demand; ready availability of supplies, raw materials and equipment; a relatively advanced legal system; and a politically and economically stable host Government, willing to cooperate. 33/

66. An overview of some of the options that facilitate the transfer of energy technologies to developing countries is presented below. Each country should assess the advantages and disadvantages of the application of these mechanisms, taking into account their economic, social, environmental and political effects. 34/

67. Tax incentives for environmental goals. These could be a useful economic policy instrument. The particular tax incentives could take various economic policy forms, including elimination or reduction of foreign investment and sales taxes, deferred taxes, tax holidays and graded taxation according to the level of environmental good achieved. Deferred taxes would give an investing company a tax break for a period of time if, for example, it intended to install more efficient or cleaner technologies during that period. Tax holidays could be based on sectors of industry with environmental priorities.

68. Tariff incentives for environmentally sound technologies. Such incentives could be a direct means for increasing the transfer and use of these technologies. Under a system of liberalized tariffs, an importing developing country would waive or substantially reduce import tariffs to those firms importing or using environmentally sound technologies in their local operations. Problems of both cost and accessibility would be lessened through a reduced tariff system.

69. Relaxation of income repatriation. This could be permitted if, for example, the foreign company was willing to invest in the transfer, use or production of clean energy technologies in the host country. Such a measure would not be likely to accomplish much by itself but could be effective in concert with other incentives.

70. Global revenue. Offset investment programmes constitute a policy option, particularly for developed countries. In these programmes, a developed country could forgo a domestic investment in environmentally sound energy technologies in order to finance a similar but more cost-effective programme in another country whose harmful technologies undermine the anti-pollution efforts of the developed country. For example, the Governments of Finland, Norway and Sweden are engaged in an effort to modernize Russian nickel smelters. The objective is to reduce sulphur dioxide emissions in each of their respective countries from 250,000 tons/year to just over 30,000 tons/year.

71. Multilateral official development assistance programmes. Most multilateral development agencies have been building environmental concerns into the planning, budget allocation, implementation and assessment of their work. There are also several new programmes to support the commercialization and transfer of environmentally sound energy technologies. Two major institutions involved in energy conservation in Hungary, the Energy Supervision Institute and the National Bank of Hungary, have been administering an industrial energy conservation loan programme since 1983. The National Bank receives funds from the World Bank which it then lends, as needed, to a network of about 20 commercial banks, who disperse the funds to industrial borrowers. The National Bank provides funds to the commercial banks for a 12-year term and commercial banks provide the same terms to industrial borrowers. The funds, in the form of hard currency, allow companies to purchase imported equipment, among other things. 35/

Sources of financing and other assistance for technology transfer

(a) Financing

72. The Department of Economic and Social Development of the United Nations Secretariat, working with key decision makers in Government and industry, heads of major developing country utilities and representatives from bilateral and multilateral organizations, instituted the Stockholm Initiative on Energy, Environment and Sustainable Development. This body places particular emphasis on power plant rehabilitation, that is, on making existing plants more efficient. To achieve this, it will work towards creating financing mechanisms to support joint ventures between developing and industrialized countries in efficient and environmentally sound energy technology development and commercialization. It will strengthen global energy and environmental management networks of bilateral and multilateral donor organizations, and relevant institutions in developing countries.

73. The Economic Commission for Europe has proposed two major programmes to promote information exchange, commercialization and the transfer of energy technologies. The first is entitled "Energy Efficiency 2000" and is directed towards trade and cooperation in energy-efficient environmentally sound

technologies and management practices between the economies in transition of Central and Eastern Europe and the market economies of Western Europe and North America. The second proposal relates to similar cooperation between the five regional commissions of the United Nations and is entitled Global Energy Efficiency 21.

74. Probably the best known and best funded new source of financing for environmentally sound technologies, including energy technologies, is the Global Environment Facility. Established in 1990 as a three-year pilot programme, it provides funding for investments and technical assistance in four focal areas: global warming, biodiversity, international waters and ozone depletion.

75. The United Nations Development Programme has established a programme entitled "Capacity 21" to redirect its activities consistent with the principles of sustainable development. It intends to "provide leadership in integrating environment and development and in capacity-building" and to serve as a channel for new and additional resources. 36/

76. The Global Energy Efficiency Initiative, launched in 1990 by a coalition of organizations in the public and private sectors of the United States of America, has three major goals: (a) to develop constituencies in developed countries to support broad-scale energy-efficiency strategies in developing countries and countries whose economies are in transition; (b) to promote a coordinated donor agency strategy; and (c) to foster a constituency for energy efficiency within those countries. The body is in the process of establishing national working groups.

Bilateral donors

77. Bilateral donors continue to be a source of financing for the transfer of environmentally sound energy technologies. A number of developed countries are initiating special programmes in support of this objective. An interesting example is the programme supported by the United States Agency for International Development, the Program for the Advancement of Commercial Technology (PACT), which was established in the 1980s with the goal of accelerating the pace and quality of technological innovation in products and processes in India. Administered by the Industrial Credit and Investment Corporation of India, which also provided some of the investment capital, PACT provides grants to support up to 50 per cent of the costs of India-United States of America joint-venture research and to develop projects for commercial application. Based on the success of this programme, the Agency recently initiated a second programme, the Program for Commercial Energy Research, with a budget of $20 million. 37/

78. None the less, the greatest sources of funds continue to be private capital markets.

(b) Other assistance for technology transfer

Commercial contracts

79. Technology transfer occurs through commercial contracts. The primary sources of environmental technology are corporations in developed countries and transnational corporations, which typically sell to developing countries. The State usually negotiates entry contracts and thus acts as a gatekeeper in all technology transfer arrangements.

80. Transfer occurs through turnkey plants, licensing arrangements, wholly owned subsidiaries of transnational corporation parent companies or joint ventures. In addition, some technology transfer occurs through more informal channels and outside of markets. Purchasers may learn of new technologies through personal contacts, meetings and trade fairs, for example, and either seek to purchase the technology or to reproduce it without patent rights.

81. However, many of the more sophisticated technologies are not yet in the public domain and remain the intellectual property of transnational corporations. In addition to the barriers posed by a lack of sufficient institutional capacity, two fundamental bottlenecks are a lack of sufficient information regarding the environmentally sound energy technologies and the shortage of capital available for purchasing mature technologies. 38/

82. In an article in the ATAS Bulletin, the author suggests that "technology transfers can be financed creatively to minimize their costs for developing countries". Since technology is "intellectual property with fungible characteristics", it can be bartered or traded, even for third world debt. 39/

Information

83. Countries need reliable, impartial information on available products and processes, including detailed descriptions of technologies, real-world examples of how they are applied, projected energy savings, range of costs, how to get access to the product and bibliographies on specific technologies. Most existing databases are not geared to the needs of developing countries and are often not even accessible to users in developing countries. Those that are available tend to be biased towards so-called appropriate technologies, that is, those that are small-scale, labour-intensive and require low capital investment.

84. The Department of Economic and Social Development provides information on various environmentally sound energy technologies through workshops, publications and training seminars and through its Advanced Technology Assessment System (ATAS). As mentioned in paragraph 63 above, the Department is also working to establish a Regional Clean-Coal Centre in the Asia and Pacific region to serve as a link between users and suppliers.

85. The Economic Commission for Africa publishes material and organizes workshops, particularly in the area of new and renewable sources of energy. A new publication, entitled Potential Contribution of New and Renewable Sources of Energy to the African Energy Supply, is based on a questionnaire which was sent to all African Member States in order to collect updated data on development and the use of renewable sources of energy and on local companies involved in

importing and/or manufacturing renewable energy systems. 40/ The Economic and Social Commission for Asia and the Pacific has published material evaluating photovoltaic systems for rural application, for training in electricity conservation in commercial and domestic subsectors and for training in energy management. It has also held meetings and exhibitions on wind energy and planning in the area of renewable energy. 41/ The Economic Commission for Europe is promoting information exchange through its proposed programmes, Energy Efficiency 2000 and Global Energy Efficiency 21. 42/

86. The United Nations Development Programme (UNDP) is establishing a Sustainable Development Network in order to facilitate freer and more rapid access to information for users in developing countries; to encourage increased communication about sustainable development; and to enhance the capacity of national institutions to meet their own needs for information and to participate in the Network.

87. The Food and Agriculture Organization of the United Nations provides information relating to a comprehensive policy framework for rural energy problems. Special attention is being given to information concerning biomass energy conversion, energy efficiency and solar and wind technologies. 43/

88. The United Nations Educational, Scientific and Cultural Organization is developing an Energy Knowledge Bank, part of which is an existing on-line referral database, ENERGY, which contains information on 5,000 research and information institutions involved in new and renewable sources of energy, as well as government agencies, trade and professional associations, training institutions, networks and others. 44/

89. The United Nations Industrial Development Organization has established the Technological Information Exchange System, a cooperative network of information and data exchange among developing countries on subjects related to technology transfer. Its Technical Advisory Services programme provides advice on all aspects of the technology acquisition process and its Investment Promotion Service, helps to identify foreign partners for sponsoring investment projects. Finally, the proposed International Centre for Hydrogen Energy Technology and the Centre for the Advancement of Solar Energy will also serve as both major sources of information and mechanisms for demonstration and commercialization.

90. Lund University in Sweden has developed The Technology Menu for Efficient End-Use of Energy. It is designed as a first-stop information resource for a broad range of energy decision makers. It presents technology descriptions, technical and cost data and illustrative economic analyses, with an emphasis on advanced technology and advances in existing technologies.

91. The International Institute for Energy Conservation (IIEC), a non-governmental organization based in Washington, D.C., has developed a Technical Information Directory, which lists organizations that provide technical information on energy-saving technologies. IIEC is also developing a database of information on the latest and most effective energy conservation policies from the industrialized world. Called the Policy Information Project, it is concentrating on four major policy areas: integrated resources planning and demand-side management; buildings; appliance labelling and standards; and transportation.

92. The International Energy Initiative was established in September 1991 by an international consortium to operate as a small, southern-led, independent and international non-governmental organization to promote the efficient production and use of energy for sustainable development. Activities include information exchange, training, analysis, advocacy and action.

Intellectual property rights

93. A pilot project on transfer of patent rights to an intermediary international organization is under way within UNDP. Called the Technology Rights Bank, it focuses on patent rights for new technologies in general rather than exclusively on environmentally sound technologies.

94. The World Intellectual Property Organization provides advice to Governments, at their request, on drafting appropriate laws and regulations for intellectual property rights. It is also available to provide training in developing countries on the transfer of environmentally sound technology that is protected as intellectual property. 45/

III. CONCLUSIONS

95. A number of clean technologies for all end-uses are ready for the market and still more are in research or are undergoing demonstration at this time.

96. The developed countries should increasingly target assistance to finance both demonstration and development of energy technologies in developing countries through bilateral and multilateral channels. This includes extending their own national demonstration and development programmes to include demonstration in other countries.

97. The developed countries should also provide lists of product and service vendors and make them available in developing countries, and should organize briefings for companies when specific opportunities arise on field trade missions and help to meet the financing and insurance needs of energy-efficiency vendors working in developing countries. Energy export trading companies, with the requisite expertise, could be established. 46/

98. The developing countries should create better policy environments for investment in energy-efficient goods and services and invite trade missions to explore import potential. Additionally, they should focus their efforts on strengthening the capacities they need to develop, adapt and commercialize environmentally sound energy technologies and to explore financial resources which could support the commercialization of such technologies in their own countries.

99. Developed and developing countries and countries whose economies are in transition should jointly establish research and development strategies for the generation, transfer and effective use of environmentally sound energy technology for the benefit of developing countries, including the provision of resources needed for the demonstration and commercialization of such technologies. International networks of power utilities and centres for the

exchange of information between users and suppliers would greatly contribute to cooperation and capacity-building.

Notes

1/ The Economic and Social Council, in decision 1992/218 of 30 April 1992, in which it recalled General Assembly resolution 46/235 of 15 April 1992 on the restructuring and revitalization of the United Nations in the economic, social and related fields, decided, inter alia, to establish a functional Commission on Science and Technology for Development, transformed from the Intergovernmental Committee on Science and Technology for Development and its subsidiary body the Advisory Committee on Science and Technology for Development.

2/ The functions previously carried out by the Centre for Science and Technology for Development have now been assumed by the Science, Technology, Energy, Environment and Natural Resources Division of the newly established Department of Economic and Social Development.

3/ See the following reports: (a) International Conference on Environmentally Sound Coal Technologies: Policy Issues and Options, Beijing, 2-6 December 1991, jointly organized by the Centre for Science and Technology for Development of the United Nations Secretariat and the State Science and Technology Commission of China; (b) International Conference on Environmentally Sound Coal Technologies: Policy Issues and Options, Madras, 15-18 January 1992, jointly organized by the Centre for Science and Technology for Development, the Ministry of Environment and Forests of the Government of India, the M. S. Swaminathan Research Foundation and Ana University, Madras; and (c) International Round Table on Environmentally Sound Coal Technologies: Policy Issues and Options, Berlin, 12-15 May 1992, jointly organized by the German Foundation for International Development (DSE) and the United Nations Department of Economic and Social Development (Berlin, DSE, 1992).

4/ C. B. Szpunar and J. L. Gillette, Comparative Analyses for Selected Clean Coal Technologies in the International Marketplace, report (ANL/EAIS/TM-39) prepared by the Environmental Assessment and Information Sciences Division, Argonne National Laboratory (Argonne, Illinois, July 1990), p. 176. See also E. Lowell Miller, "The clean coal initiative: an appropriate response to complex environmental issues", paper presented at the Conference on Coal and the Environment: Asia 2010, Honolulu, 11 and 12 July 1991.

5/ Michael Willingham, "Strategies for implementing power sector efficiency", paper prepared for the Consultative Meeting, Stockholm Initiative on Energy, Environment and Sustainable Development (SEED)", 13-15 November 1991.

6/ Jayant Sathaye and Stephen Meyers, "Transport energy use in developing countries", ATAS Bulletin: Energy Systems, Environment and Development, Issue 6 (United Nations publication, Sales No. E.91.II.A.4), pp. 323-329. See also the introduction to section 6, "Technology for transportation demand", in ibid., pp. 315-319.

7/ Bernard A. James, "Alternative vehicle fuels: the Canadian experience", ATAS Bulletin: Energy Systems, Environment and Development, Issue 6 (United Nations publication, Sales No. E.91.II.A.4), pp. 376-381. See also, in ibid., Jorge A. Doma, "Substitution of compressed natural gas for petroleum fuels in Argentina", pp. 382-383; Lourival Carmo Monaco, "Ethanol as alternative transportation fuel in Brazil", pp. 384-396; and Mohamed L. Baraka, "The Kenyan experience with ethanol for transportation", pp. 397-399.

8/ United States Congress, Office of Technology Assessment, Building Energy Efficiency (Washington, D.C., United States Government Printing Office, May 1992), pp. 50-60.

9/ ATAS Bulletin: Prospects for Photovoltaics: Commercialization, Mass Production and Application for Development, Issue 9 (United Nations publication, Sales No. E.92.II.A.14), p. vi.

10/ Ibid., p. 5.

11/ O. A. El-Kholy and H. Sharon, "The establishment of a Centre for Applications of Solar Energy (CASE): a draft feasibility report", prepared for the United Nations Industrial Development Organization, July 1991, p. 7.

12/ Michael Philips, Energy Conservation Activities in Latin America and the Caribbean (Washington, D.C., International Institute for Energy Conservation, 1990), pp. 2-4.

13/ Ashok Gadgil, Arthur H. Rosenfeld and Lynn Price, "Making the market right for environmentally sound energy-efficient technologies: United States buildings sector successes that might work in developing countries and Eastern Europe", paper presented at ESETT'91: International Symposium on Environmentally Sound Energy Technologies and their Transfer to Developing Countries and European Economies in Transition, Milan, Italy, 21-25 October 1991, pp. 5-7.

14/ Gilberto De Martino Jannuzzi and others, "A critical look at residential electricity conservation campaigns in a developing country environment", unpublished paper, p. 3.

15/ Lee Schipper and others, "Energy use in Denmark: an international perspective", unpublished paper, October 1992.

16/ Michael Philips, Energy Conservation Activities in Africa and Eastern Europe (Washington, D.C., International Institute for Energy Conservation, 1990), pp. 10-12.

17/ Robert G. Skinner, "World energy future: the demand side challenge", paper prepared on behalf of the International Energy Agency of the Organisation for Economic Cooperation and Development and presented to the 9th International Symposium on Petroleum Economics, Quebec, October 1992, p. 6.

18/ Gadgil et al., op. cit., p. 7.

19/ Ibid., p. 8.

20/ Skinner, op. cit., p. 16.

21/ Ibid.

22/ Daniel A. Roling, "Financing energy projects", paper presented on behalf of Merrill Lynch Capital Markets at the Conference on Coal and the Environment: Asia 2010, Honolulu, 11-12 July 1991, p. 12.

23/ Philips, Energy Conservation Activities in Latin America and the Caribbean ..., p. 13.

24/ Philips, Energy Conservation Activities in Africa and Eastern Europe ..., pp. 7-9.

25/ Ibid., p. 11.

26/ Michael Philips, Energy Conservation Activities in Asia (Washington, D.C., International Institute for Energy Conservation, 1991), p. 3.

27/ International Institute for Energy Conservation, Demand Side Management for Thailand's Electric Power System: Five Year Master Plan (Washington, D.C., November 1991).

28/ International Round Table on Environmentally Sound Coal Technologies: Policy Issues and Options, Berlin, 12-15 May 1992, report of the Chairman, p. 14.

29/ Skinner, op. cit., p. 17.

30/ United Nations Educational, Scientific and Cultural Organization, "Energy for sustainable development and environmental protection" (UNESCO/SC/EST/92), pp. 7-9.

31/ The Science and Technology Branch of the Science, Technology, Energy, Environment and Natural Resources Division of the United Nations Department of Economic and Social Development is working with a number of technology assessment institutions world wide to help them establish a new international non-governmental organization to deal with technology assessment. A database, which has been compiled as a part of the Network of the Advanced Technology Assessment System (ATAS) will be made available to this new organization upon its creation.

32/ International Round Table on Environmentally Sound Coal Technologies: Policy Issues and Options, Berlin, 12-15 May 1992, report of the Chairman.

The United Nations Industrial Development Organization has proposed the creation of two of these centres, for hydrogen energy technology and solar energy. See El-Kholy and Sharan, op. cit.

33/ Roling, op. cit., pp. 8-10.

34/ Large parts of the material in the sections on tax and tariff incentives, income repatriation, global revenue and official development

assistance are taken from draft papers prepared by the former United Nations Centre on Transnational Corporations, entitled: "Options to facilitate transfer of environmentally sound technologies to developing countries on favourable terms" (July 1991). These papers are currently undergoing revision and will be published at a later date.

35/ Philips, Energy Conservation Activities in Africa and Eastern Europe ..., pp. 15-16.

36/ United Nations Development Programme, report of the Workshop on the Sustainable Development Network, New York, 8-10 September 1992, p. 9.

37/ Debbie Bleviss, "Focus on technology cooperation in energy efficiency", in World Resources, 1992-93, (New York and Oxford, Oxford University Press, 1992), p. 156.

38/ Peter M. Haas, "Greenhouse warming, technology cooperation and developing country concerns", paper prepared for the Office of Global Change of the Bureau of Oceans, Environment and International Scientific Cooperation, United States Department of State, May 1992.

39/ Juan R. Zarco, "Creative financial techniques for technology transfer to less developed countries", ATAS Bulletin: Environmentally Sound Technology for Sustainable Development, Issue 7 (United Nations publication, Sales No. E.92.II.A.6), pp. 181-187. See also report of the Workshop on Creative Financing for Environmentally Sound Technologies, organized by the Centre for Science and Technology for Development, Belém, Brazil, 2-7 December 1990.

40/ Letter from Peter N. Mwanza, Chief, Natural Resources Division, Economic Commission for Africa, 26 October 1992.

41/ Letter from M. Rahmatullah, Acting Chief, Division of Industry, Human Settlements and Environment, Economic and Social Commission for Asia and the Pacific, 11 September 1992.

42/ Letter, with enclosures, from John A. Kennerley, Deputy Director, Industry and Technology Division, Economic Commission for Europe, 26 October 1992.

43/ Letter from Gustavo Best, Senior Energy Coordinator, Research and Technology Development Division, Food and Agriculture Organization of the United Nations, 28 October 1992.

44/ United Nations Educational, Scientific and Cultural Organization, op. cit., pp. 4-6.

45/ Letter from Khamis Suedi, Director, Bureau for Relations with International Organizations, World Intellectual Property Organization, 7 September 1992.

46/ Bleviss, loc. cit., pp. 155-156.